

1904, from an example without a skull, as *Midas goeldii*, but which had recently been redescribed by Dr. Ribeiro, from the living animal, as *Callimico snethlageri*, a new genus and species "intermediate between *Callicebus* and *Mico*."

Mr. Thomas's examination of Dr. Ribeiro's type specimen, sent over by the authorities of the Para Museum, showed that *Callimico* really was intermediate between the Cebidæ and Callitrichidæ, having the external characters of a Marmoset, notably the elongated claws, combined with the shape of skull and molar formula of the Cebidæ. The molars themselves possessed no hypocone, as in the Marmosets.

The animal being, therefore, intermediate in character between the two families Cebidæ and Callitrichidæ, there was great difficulty in deciding as to the effect its discovery should have on the systematic arrangement of the American Monkeys, and as to whether these two families ought still to be kept separate.

On the whole, as causing least disturbance, Mr. Thomas thought that the best plan would be to form a special subfamily, the Callimiconinæ, for *Callimico*, and to include this as a second subfamily with the Cebinæ in the family Cebidæ. But that *Callimico* was a real genetic link between the two families there seemed to be no doubt whatever.

PAPERS.

- Contributions to the Anatomy and Systematic Arrangement of the Cestoidea. By FRANK E. BEDDARD, D.Sc., M.A., F.R.S., F.Z.S., Prosector to the Society.

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(Text-figures 1-10.)

VII. ON SIX SPECIES OF TAPEWORMS FROM REPTILES, BELONGING TO THE GENUS *ICHTHYOTÆNIA* (s. l.).

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The genus *Ichthyotænia* (whose possible subdivisions I discuss later) is chiefly found among freshwater fishes—that is, most of

the species infest those vertebrates. Two species, however, viz. *I. schultzei** and *I. lönnbergi*†, have been met with in amphibians—the former in *Rana adspersa*, the latter in *Necturus*. The other members of the genus are known to inhabit reptiles, both snakes and lizards, and, if we allow *Tetrabothrium trionychium*‡ to be of this genus, tortoises.

§ *Some Species of Ichthyotænia (Acanthotænia) from Monitor Lizards.*

Our knowledge of the parasites of Monitor Lizards is obviously not very extensive at present, for very few species of these lizards have been examined or at any rate have yielded parasites. These have been referred to five genera, viz. *Duthiersia*, *Scyphocephalus* (both of which are Bothriocephalids), *Pancerina*, *Palaia*, and *Ichthyotænia* (including *Acanthotænia*). With the two first-named genera I do not concern myself in the present communication. The name *Acanthotænia*, whether necessary or not, was apparently given by v. Linstow under a misconception of the structure of the worm of which he gave an account under the name of "*Acanthotænia shipleyi*, nov. gen. et sp."§. In my opinion it was probably by reason of having not seen the peripherally situate vitelline glands, and of having wrongly termed the ovaries vitelline glands, that v. Linstow created the genus, rather than by virtue of the densely-set spinelets upon the scolex, though the latter clearly suggested the name. Two worms from another species of *Varanus* had been previously (in 1900) described by v. Ratz|| as members of the genus *Ichthyotænia*; and this name is retained by Schwarz¶, who, however, was apparently unacquainted with v. Linstow's paper, which is not quoted in his list of literature. Finally, at about the same time as Schwarz, T. H. Johnston** described under the name of *Acanthotænia* a fourth species from *Varanus varius*. So far as I am aware, this exhausts the species of *Ichthyotænia* which have been recorded from lizards of the genus *Varanus*.

It appears to me to be probable that *Palaia varani*, a new species and genus described by Dr. Shipley†† from *Varanus indicus*, is also to be referred to this genus *Ichthyotænia*. It is true that Johnston, in his memoir upon *Ichthyotænia (Acanthotænia) tidswelli*, is not of that opinion; there are, however, certain reasons which seem to be favourable to its inclusion within the present genus.

* Hungerbühler, Jen. Denkschr. 1910.

† Fuhrmann, "Die Tæmien der Amphibien," Zool. Jahrb. ix. Anat. 1896.

‡ Lönnberg, "Ueber eine neue Tetrabothrium-species, &c.," Centralbl. Bakt. u. Paras. xv. 1894.

§ Centralbl. Bakt. u. Paras. xxxiii. 1903, p. 534.

|| Centralbl. Bakt. u. Paras. 1900; C. R. Soc. Biol. 1900; Arch. de Paras. iv. 1900.

¶ "Die Ichthyotæmien der Reptilien, &c.," Inaug.-Diss., Univ. Basel, 1908. For a copy of this I am greatly indebted to the author.

** "On a new Reptilian Cestode," Proc. Roy. Soc. N.S. W. vol. xliii. 1909, p. 103.

†† Description of Entozoa &c. in Willey's 'Zoological Results,' Cambridge, 1900.

It must be remembered that when Dr. Shipley described *Palaia varani* the genus *Ichthyotenia* had not actually been described from *Varanus*, since Ratz's memoirs appeared contemporaneously with that of Dr. Shipley. Dr. Shipley himself thought that *Palaia* came nearest to *Oochoristica*, a genus which also occurs in reptiles. He did not consider *Panceria*, to which I shall refer immediately in this connection.

The reasons which lead me to regard *Palaia varani* as a species of *Ichthyotenia* are largely negative, but there are also one or two positive facts. Firstly, the only Tænioid parasites of *Varanus* are *Ichthyotenia* and *Pancerina*, and as to the former it is now known that four species of *Varanus* harbour different species of *Ichthyotenia*. This is not obviously conclusive against the occurrence of another genus; but it may be borne in mind as something of an argument. The general structure of *Palaia* is not in the least opposed to its inclusion in the genus *Ichthyotenia*. It is of course true that the same characters would fit other genera, and unfortunately the reproductive system could not be described in any detail. The author gives a figure of a transverse section of the worm, whence it would appear that the transverse muscular layer lies in the medullary parenchyma, as has been described by Schwarz in his memoir referred to on this genus *Ichthyotenia*. The most important positive reason for the inclusion of *Palaia varani* in the genus *Ichthyotenia* is in the character of the eggs, which are particularly described and figured as lying in clumps, the individual eggs being adherent. This is highly characteristic of the reptilian members of the genus, and I have something in the present paper to say upon the matter.

The genus *Pancerina* (originally described under the pre-occupied name of *Panceria*) occurs in *Varanus arenarius*, whence it has been described by Sonsino* and Stossich†, more fully by the former of these two authorities. *Pancerina* is placed by systematists‡ in the neighbourhood of *Oochoristica*, to which Dr. Shipley thought that *Palaia* was allied. The double reproductive organs in each proglottid prevent any confusion between this genus and *Ichthyotenia*. Nevertheless there do not appear to me to be any positive facts which forbid the near relationship of *Pancerina* and *Ichthyotenia*, there being no definite statement by Sonsino as to the vitelline gland.

In two specimens of *Varanus niloticus* a series of small tape-worms was found which clearly belong to this genus *Ichthyotenia*. I am inclined to think that the worms from one specimen of this *Varanus* are different from those found in another specimen of the lizard. But inasmuch as the worms of one series were not mature, I am not able to speak with certainty as to some necessary specific characters. Moreover, I had the opportunity of examining one series in the living condition, and am not therefore able to report

* Monit. Zool. Ital. vi. 1895, pp. 121 & 189.

† Boll. Soc. Adr. Trieste, xvi. 1895, p. 42. Described as *Tenia varani*.

‡ *E. g.*, Ransom, Bull. U.S. Nat. Mus. no. 69, 1909.

certain characters as obvious in the living tapeworm which could not be detected in the alcohol-preserved examples from the other lizard. In the meantime I furnish a separate description of the two series of tapeworms.

The immature worms are distinctly smaller than the others, which is again in favour of regarding them as different species. It is interesting to note that in *Varanus niloticus*, as in *Varanus varius* (as will be pointed out later), a small and a comparatively large species of *Ichthyotenia* occur together. But it must be borne in mind that in the case of *Varanus niloticus* they did not infect the same individual.

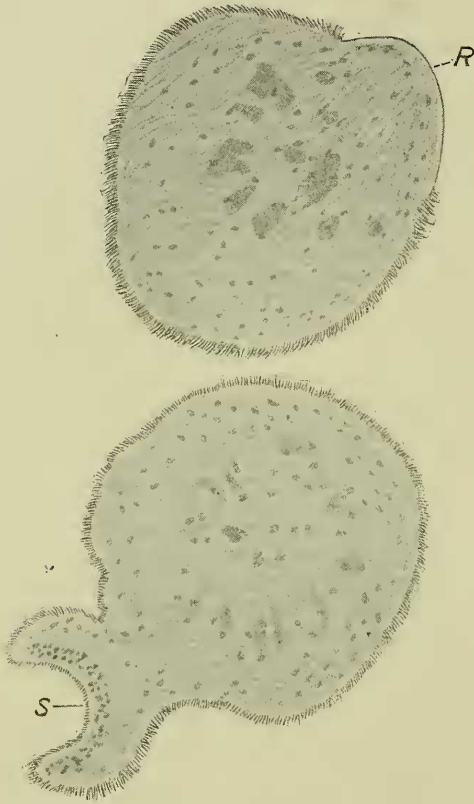
These worms are indeed quite small, measuring not more than from 10 to 15 mm. They present quite the appearance of a fine white thread, as in the case of *Ichthyotenia tidswelli* and of one of the species which I describe in the present paper from *Varanus varius*. I have studied them entire and in transverse and sagittal sections; but owing to their immaturity my description has many lacunæ, in consequence of which I do not propose to give a name to the species. The most striking external character is one that I have not met with in any other tapeworm. The base of the scolex and a certain amount of the ensuing strobila was tinged of a bright carmine, which I thought at first was merely a blood-stain. It is not, however, blood-colour by reflected or transmitted light, and is distinctly bright pink. Moreover it resisted for a certain period the action of alcohol, but was ultimately washed out. This pigment does not occur in the form of granules, like the black pigment which is not rare in the heads of tapeworms. It is diffused through the tissues, though I am not able to delimit the regions where it occurs. It is highly characteristic and quite unmistakable. Nothing of the kind appears to be mentioned by Johnston in *Ichthyotenia (Acanthotenia) tidswelli*.

The scolex of this worm is very mobile, and the anterior end (the rostellar region) can be protruded far or flattened down or actually retracted, thus producing an apical and conical cavity which might be mistaken for a sucker-like structure in an individual which had been fixed in this position. As the majority of tapeworms are always described from preserved examples, it is worth while to dwell upon this great flexibility of movement; and, moreover, Riggenbach has used the presence of an apical dimple as an aid to the systematic arrangement of the genus *Ichthyotenia**. Among the preserved examples which I also studied during life I find some with fully expanded and others with retracted rostellum. This species is at least to be contrasted in this respect with that described by Johnston, in which the author particularly states that the rostellum is represented by a muscular plug which is not retractile. In the same way the four suckers are very mobile and can be protruded in the shape of finger-like processes. There are, of course, no hooks

* Rev. Zool. Suisse, iv. 1896, p. 165.

upon the scolex; but there is a fine investment of minute spinelets, which are most densely set but are absent from the apex of the scolex. The suckers seem to look upward when in a state of rest.

Text-fig. 1.



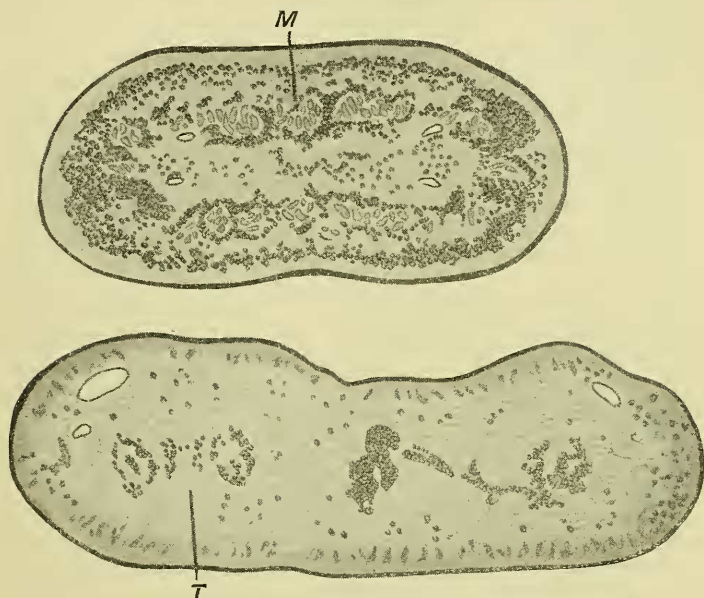
Two sections through the scolex of *Ichthyotænia* (*Acanthotænia*) sp.

The upper figure displays the partial protrusion of the rudimentary rostellum (R) permitted (?) by the absence of external spinelets in this region as shown in the figure. The lower figure passes through a sucker (S), and here the covering of spinelets is seen to extend into the interior of the sucker.

Transverse sections through the scolex (see text-fig. 1) show an anteriorly situated muscular organ comparable with a rostellum. It is rudimentary, and not like that which I describe below as characteristic of the second species of tapeworm from this *Varanus*. The suckers are borne at the base of the apical cone, and the actual suckers are on processes of the body, and not sessile upon

it, as they have been figured in some other species. Between the layer of muscles which forms the actual sucker and the tissue of the body is a considerable plexus or convoluted section of the water-vascular tube not shown in the figure. I should say that I confirm Johnston's statement for *Ichthyotenia tidswelli* as to the spinelets covering the interior of the sucker for the present species. The strong muscles which retract the suckers and the scolex generally are massed in the neck-region of the strobila into a thick layer of longitudinally running fibres, which reduce the medullary region of the body very considerably. The appearance reminds one of *Dasyurotenia robusta*, where the neck-region has also particularly stout muscles*.

Text-fig. 2.



Two transverse sections through the strobila of the same species of *Ichthyotenia* (*Acanthotenia*).

The upper figure represents the "neck"-region, and shows the strong longitudinal muscle-bundles (M). The lower figure is from the posterior region of the body, and shows the absence of these muscles. T, testes; on the right are shown other parts of the reproductive system, also in an immature condition. The water-vascular tubes are shown white in both figures.

The fibres (see text-fig. 2) are collected into bundles of various sizes, which are close together and completely encircle the body.

* See Beddard, P. Z. S. 1912, p. 684, text-fig. 97.

Between this row of bundles and the subcuticular layer are other longitudinal fibres which are not massed so obviously into a series of separated bundles. Farther back in the body the bundles get smaller and further apart, and ultimately disappear altogether.

The strobila of this tapeworm shows posteriorly a very marked delimitation between the individual proglottids, which are constricted at their junctions and thus produce a necklace-like appearance, as is often seen in other tapeworms, e. g., *Davainea*. I describe the same appearance in an equally small or rather smaller species from *Varanus varius*. In transverse sections through the ripest segments that I have been able to examine, but which were by no means fully mature, the structure of the body is much like that of other *Ichthyotenia*. The general parenchyma is very delicate; the subcuticular layer of glandular cells is very marked, and the cells are deeply stained as compared with the neighbouring parenchyma.

I could find no layer of longitudinal fibres within the subcuticular layer. They seem to me to be as plainly absent from this species as from the others with which I deal in the present communication. Nor could I find any calcareous corpuscles with an obvious appearance like those of the second species of *Ichthyotenia* from this *Varanus*, which I shall describe later.

In the anterior segments of the body there are two *water-vascular tubes* on each side of the body, the dorsal tube nearly accurately overlying the ventral; they are about equisized. In the segments which I am now considering the ventral vessel is very large, comparatively speaking, and often lies right up against the subcuticular layer, thus emphasizing the difficulty—to which I also direct attention in other species—of distinguishing the cortical from the medullary layer. The much smaller dorsal vessel is present, but it is not always very easy to see.

With reference to the *generative organs* I am not able to say much, as they were immature. The ducts, however, pass between the two water-vascular tubes on their way to the exterior.

The *cirrus* is represented by an elongated wide tube into which the sperm-duct opens at the posterior end. This is surrounded posteriorly by a muscular sac, which is the cirrus-sac. The cirrus hardly narrows before its opening on to the exterior. The sperm-duct is only coiled once or twice upon itself, and this part lies within the cirrus-sac. The generative openings, it should be mentioned, occur either on one side of the segment or the other. The middle area of the proglottid is free from testes, of which three or four lie on each side of it; so that in a given proglottid the transverse rows of testes contain six or eight of these gonads. The ovary is median. I am aware that the above facts are not in any way distinctive of the species. They only prove that it belongs to the genus *Ichthyotenia*. From the characters other than those afforded by the generative organs it is hardly safe to attempt the definition of a new species of this genus. There is, indeed, nothing which positively prevents the inclusion of this

parasite of *Varanus niloticus* within the species *Ichthyotenia tidswelli*, excepting, indeed, the presence in the latter of a layer of longitudinal muscular fibres in proglottids with fully developed testes. These muscles I can only find anteriorly in my species. It appears to me, however, to be imprudent to give a name to the *Ichthyotenia* which I have just described until a good deal more is known about its anatomy than is contained in the present paper.

In addition to the small species which has just been described, *Varanus niloticus* is infested by a larger *Ichthyotenia* which I term *I. nilotica*, regarding it as an undescribed species.

I am uncertain about the length, inasmuch as I had to deal with fragments only of various sizes. The largest fragment with a scolex attached measured about 20 mm. But as the posterior region of this piece had not nearly acquired the dimensions of obviously mature fragments, at least 10 mm. can be, I think, safely added on to the length. The species is fairly slender, but not in the least thread-like, and the stoutest proglottids do not reach much more than .5 mm. in diameter. The most salient external feature of this species differentiates it at once from *Ichthyotenia varia* and *I. gracilis*; there is no external appearance of segmentation without a careful examination with a lens. Only the slightest constriction marks the boundary line of adjacent proglottids. In this feature the present species agrees with *I. biroii* and *I. tidswelli*. The ripe segments get to be longer than broad, but they are apparently never very long.

The scolex has the usual *Ichthyoteniid* characters. I only found two scolices, and in both the conical rostellum was long and is possibly therefore not retractile. The four suckers are clustered round its base and look forwards. I observed the usual dense investment of spinelets which led v. Linstow to bestow the name of *Acanthotenia* upon the genus. One of the two scolices was cut into a series of transverse sections for the purposes of further investigation. At the apex of the rostellum there was a distinct sucker-like depression carried on a narrow prolongation of the rostellum, which, however, showed no such great specialization in its tissues as the four suckers proper, though it is, I am sure, a permanent structure and not a mere temporary involution of the rostellar region. Such a structure has been discerned in other species of reptilian *Ichthyotenia*, and has been regarded as the homologue of the rostellum of other tapeworms. In the smaller *Ichthyotenia* from *Varanus niloticus* that has just been described the apical structure was obviously of the nature of a retractile rostellum.

The four suckers are borne upon prolongations of the scolex in which lie water-vascular tubes, which latter were not quite so conspicuous as in the last mentioned species of *Ichthyotenia*. It is these outgrowths of the scolex that are the motile parts of the scolex when the suckers are protruded or withdrawn. To a naked-eye examination the suckers appear to be sessile upon

the scolex. It is not impossible that we have here an intermediate state of affairs, where a true sucker (acetabulum), originally only an accessory structure (as has been held), has nearly completely replaced the phyllidium, of which comparatively small traces remain. In connection with this matter, it must be borne in mind that the systematic position of the genus *Ichthyotenia* is not yet settled. Some place it in a family, *Ichthyotæniidæ* of the group *Tetraphyllidæ*; while Lönnberg* dwells upon its likeness to *Tetrabothrium*, and Lühe † places the certainly closely allied if not congeneric *Crepidobothrium gerrardi* also in the genus *Tetrabothrium*.

The muscles which move the scolex are well developed in this species, but by no means so prominent as in the last species. This is remarkable when we consider that *Ichthyotenia nilotica* is the larger of the two species. On the other hand, I have no information as to the mobility of the scolex in the present worm. Immediately behind the scolex these muscles are massed into regular and, of course, longitudinally running bundles of fibres, which are not so large as are those of the last, and therefore do not contain so many individual fibres. These bundles lie below the subcuticular layer, and occupy exactly the position in which the longitudinal fibres of other species of *Ichthyotenia* are represented by Schwarz. But in the present species, as in the last, they only exist, and for a very short length, in the part of the body immediately following the scolex. I counted ten of these bundles in a section in the neck-region, only just behind the scolex; they form a complete ring, and thus lie without as well as within the water-vascular tubes. Further back the bundles decrease in number, and in mature segments are not recognisable. The greatest number of fibres in a bundle is 7 or 8.

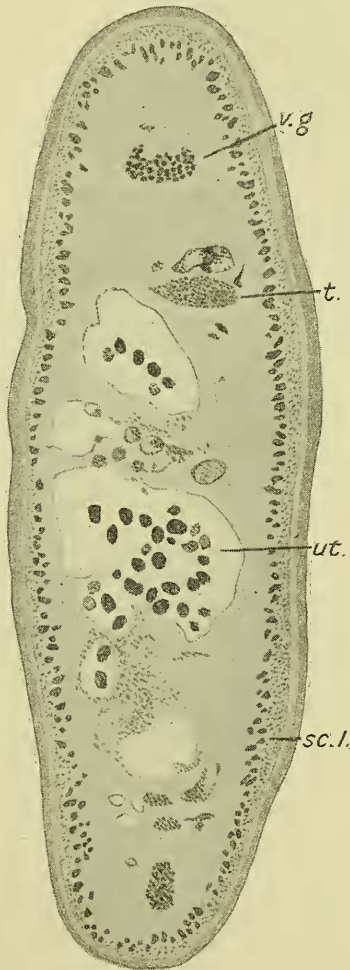
The structures seen in a transverse section of a proglottid (text-fig. 3) are not different from those of other species of this genus which I describe in the present paper. The delicate layer of longitudinal fibres below the cuticle is plain and also the very strongly marked subcuticular layer of darkly staining cells. I could find no longitudinal muscular layer beneath this, nor is there any boundary line that I could discover between the cortical and medullary parenchyma. *Calcareous bodies* were very evident here and there. The *water-vascular tubes* are very plain in the anterior region as two tubes on each side. These are not very different in calibre, and the dorsal and ventral of each side were more or less accurately superposed. In the mature segments I can find only one tube on each side, which I am inclined, mainly on account of its small size, to regard as the dorsal water-vascular tube. In longitudinal horizontal sections I could detect no evidence of more than a single water-vascular vessel on each side. I have also been unable to find any branching of this tube to join the corresponding vessel on the opposite side of the body. A single

* Centralbl. Bakt. u. Paras. xv. 1894, p. 801.

† In a footnote to a paper, "Zur Kenntniss einiger Distomen," Zool. Anz. 1899.

water-vascular vessel on each side of the body is also described for *Ichthyotenia biroi*. I find, however, that in completely ripe

Text-fig. 3.



Transverse section through the strobila of *Ichthyotenia (Acanthotenia) nilotica*.

sc.l. Subcuticular layer. *t.* Testis. *ut.* Uterus appearing as an irregular series of cavities with numerous contained embryos. *v.g.* Vitelline gland.

segments with embryos a much larger ventral vessel is present in addition to the dorsal.

There are various points in the structure of the reproductive system of organs which help to fix the distinctness of this species from others, and especially from *Ichthyotænia biroi*, to which it is most nearly akin. The *testes* occupy the greater part of each ripe proglottid, and there is no very definite median area free from them. There is nothing so definite, for instance, as the conditions figured by Schwarz in *Ichthyotænia nattereri**. In horizontal sections of a series of mature segments the difficulty of distinguishing the boundary lines between successive segments, plainly felt on examination of the entire worm with a lens, is increased by the lack of a definite break between the reproductive systems of each segment. There is an appearance of complete continuity not seen in corresponding sections of the other species which I have studied.

The *vas deferens* behind the cirrus-sac is closely coiled, this coiled region reaching quite or nearly halfway across the proglottid. The calibre of this region of the *vas deferens* does not vary in any appreciable way from point to point. That is to say, there is not, so far as I have been able to ascertain, any vesicula seminalis like that of *Ichthyotænia gracilis* described in the present paper. It is important to note this fact, since in *I. biroi* the existence of a vesicula behind the cirrus-sac has been stated, but Schwarz was not able to see it. The tangled coil of the *vas deferens* lies across the segment with a slight inclination towards the anterior margin. Within the cirrus-sac the *vas deferens* is also coiled.

The present species is the only one of those known to me at first hand, and which are described in the present paper, which possesses an armed *cirrus*. This organ, when protruded, is covered externally with very numerous and closely-set hooks. In sections through the cirrus-sac, where it is not protruded, the spines can be seen lining the canal of the cirrus. Schwarz figures in the case of *Ichthyotænia marenzelleri*† an actual protrusion of the cirrus-sac itself in an apparently unaltered condition. There is no doubt that in the species with which I am here concerned the outpushing of the cirrus is an eversion of the cavity of the cirrus, since the spines lining the latter become external in the everted organ.

The cirrus-sac and vagina open very slightly in front of the middle of the lateral margin of the segment. The generative apertures, of course, alternate from the side of the body in different segments, and there is also, as in many but not in all species of the genus, an alternation in the relative positions of the two orifices, the cirrus being sometimes anterior and sometimes posterior. The generative ducts pass between the dorsal and ventral water-vascular tubes, and there is in the present species no cloaca genitalis. This is rendered particularly evident in one specimen which I mounted entire in glycerine, and of

* *Loc. cit.* Taf. i. fig. 2, h.

† *Loc. cit.* Taf. iv. fig. 12, c, b.

which the cirri in many segments were extruded in various degrees of completeness. By the side of the cirrus in several proglottids was an oval projection, which is clearly the slightly everted or protruded vagina. Von Ratz has described the ovary of *Ichthyotenia biroi* as possessing digitiform processes. The ovary of *Ichthyotenia nilotica* is solid, and the two wings are not frayed out into processes; its appearance is, in fact, that of most species of the genus. The vagina when not fully mature is apt to be arranged, in that part of it which runs parallel with the cirrus-sac, in a sinuous line. In quite fully mature segments the vagina runs in quite a straight course in this region, and is considerably dilated, the calibre increasing as it passes back. It is not easy, however, to distinguish any part of it as a receptaculum seminis. But, on the other hand, it probably corresponds to the "spindelförmige Anschwellung" seen by von Ratz but not by Schwarz in the species *Ichthyotenia biroi*. After the pear-shaped swelling, which is quite plain in *I. nilotica*, the vagina dwindles greatly in calibre and becomes quite a narrow tube. That this dwindling occurs rather suddenly gives an additional appearance of a receptaculum seminis to the tract lying in front of it. As in other species, the vagina has an adventitious sheath formed by an ingrowth of the subcuticular layer. The vagina, when it reaches the middle of the body, passes back in a straight line, and is a little coiled in the neighbourhood of the ovary and before it becomes connected with the shell-gland. The vagina lies dorsally of the ovary and the uterus lies ventrally of the ovary in this region. The shell-gland is large, and extends across about half of the dorso-ventral diameter of the proglottid. It lies behind the median junction of the two wings of the ovary. Close to it, but upon the ventral side of the median, is the very obvious and strongly muscular "Schluckapparat." The vitelline glands form the usual lateral strips.

Before the eggs are ripe the uterus is visible as an empty cavity running antero-posteriorly through the whole of the middle of the segment. It is straight, with numerous closely adpressed and irregular outpocketings. The appearance may also be described as of a wide tube partially divided by numerous ingrowths of the wall. When fully formed and containing ripe embryos the uterus extends over the greater part of the segment from side to side, though it does not touch the lateral vitelline glands. It has an exaggeration of the same structure, the lateral diverticula being prolonged. In transverse sections through ripe proglottids (see text-fig. 3) it often appears as a series of more or less isolated and circular cavities occupying the middle of the segment. The ripe eggs lie loosely in the cavities of the uterus, generally aggregated into masses. The shell of the egg is very thin and unrecognisable, which distinguishes this species at once from *Ichthyotenia varia*, described later in the present paper. The eggs of *Ichthyotenia nilotica* are also—and, perhaps, therefore—distinctly smaller than those of the other species just mentioned.

While there is no need to insist upon the difference between *Ichthyotenia nilotica* and any of the other species described in the present communication, it is equally clear that there are considerable resemblances between that species and *I. biroi*. They are however, as I think, distinct. In the first place, our knowledge of these parasites of *Varanus* shows so far that, while a particular species of *Varanus* may harbour more than one species of *Ichthyotenia*, the same species of *Ichthyotenia* does not infest more than one species of *Varanus*. But there are also definite structural distinguishing marks. Of these the most important is the form of the ovary, which is quite normal in *I. nilotica* and peculiar in *I. biroi*. The spiny lining of the cirrus appears to be a further distinguishing mark, as Schwarz in his general account* of the anatomy of the genus says nothing about it.

An example of *Varanus varius* contained specimens of tapeworms which were clearly referable to two species—one very much larger than the other. The smaller species was represented by only one individual, which was a delicate thread-like worm, quite agreeing with *Acanthotenia tidswelli* of Johnston† in that “to the naked eye it appears like a piece of fine white thread.” Furthermore, the head is covered with minute densely-set spinelets. In other external characters, however, this small worm does not agree with *Acanthotenia tidswelli*. It is very much smaller, not reaching beyond 6 mm. in length as compared with 30 mm. for *Acanthotenia tidswelli*; there are abundant calcareous bodies, and the segments are rather clearly defined after the neck. The neck is quite short, and the segments soon get to be as long as they are broad. I counted altogether forty distinct segments after the neck.

Of these the last few had an oval outline and were deeply constricted at their junctions. Whether these were fully mature segments or not I am unable to state, as I could not see the organs of reproduction in the single specimen, which was mounted entire in glycerine; nor, indeed, could I see the generative pores. It is thus only by inference that the worm is referred to the genus *Ichthyotenia* (from which it is, as I think, very difficult to distinguish *Acanthotenia*), with which, however, all available characters agree in uniting it. I should say that, as might be expected, the head is entirely unarmed with hooks; it is considerably wider than the ensuing neck and the body for some distance. Mr. Johnston found the minute spinelets of the scolex in *A. tidswelli* to occur also upon the following proglottids. I have not been able to ascertain that this is so in my species. On account of the very scanty amount of notes which I am able to set down concerning this species, I do not for the present give it a name.

The second very much larger species, which I propose to name

* *Loc. cit.* p. 13.

† *Proc. Roy. Soc. New South Wales*, vol. xliii. 1909, p. 103.

Ichthyotænia varia, was represented by a great number of segments, but there was not a complete worm; so that I cannot judge of the length of the species. I can say something, however, of its dimensions as compared with the other species of *Ichthyotænia* which inhabit the genus *Varanus*. The longest piece measured 28 mm., and as this consisted of long and mature proglottids only, it is certain that a complete individual would measure more than 30 mm. A single proglottid, indeed, in one or two cases was 4 mm. long, and thus the worm is obviously relatively a large one as compared with other species that inhabit *Varanus*. The breadth of mature proglottids was fully a millimetre, so that this species of *Ichthyotænia* is not at all thread-like but flattened and ribbon-like: indeed, in all external characters a typical member of the genus. Among the numerous fragments of varying sizes and maturity was one piece which included a scolex, which is, I think, probably not to be referred to the same species. I shall deal with the characters of this individual, which measured 34 mm., later. The pieces of the large worm were investigated by sections, and also pieces were mounted entire, stained and unstained, in glycerine.

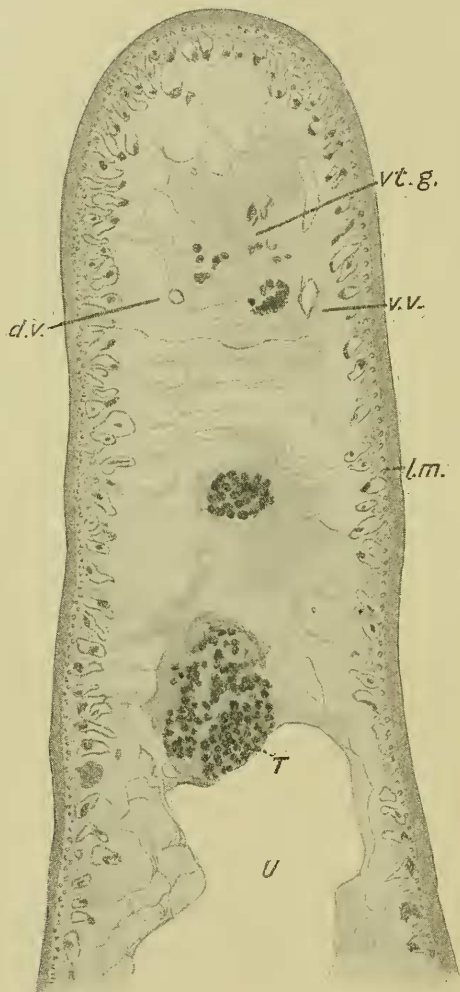
In transverse sections of mature proglottids (see text-fig. 4, p. 18) the flattened character of the worm is very obvious. The medullary parenchyma is much more coarsely spongy than I have observed it to be in many tapeworms, and I have been unable to detect a transverse layer of muscle separating the medullary from the cortical layer. Moreover, the cortical layer must be thin, for the coils of the vas deferens extend dorsally and ventrally to just beneath the cellular subcuticular layer. The latter layer is very strongly marked, as appears always to be the case in this genus. The large cells are very deeply stained by hæmatoxylin. Between it and the cuticle is a delicate layer of longitudinal fibres; but I can find no other layer of longitudinal muscles such as are figured by Schwarz* and Johnston †, or have been described by myself in the present paper in an *Ichthyotænia* from *Varanus niloticus*.

It would, I think, be difficult to miss such a layer in my preparations were it present. But while there is no definite layer of muscles, there are certainly here and there large longitudinally running fibres which I have observed both in transverse and longitudinal sections. But they are scarce. As for the transverse layer which Schwarz figures ‡ as occupying the greater part of the medulla, I have only been able to notice a rather stretched condition of the parenchymatous meshwork, particularly at the extremes of the proglottids where there are no gonads developed. There are very probably muscles in this meshwork running in a transverse direction; there certainly are such fibres running in a dorso-ventral direction. I cannot, however, find thick layers such as I understand Dr. Schwarz to insist upon in *Ichthyotænia calmettei*. Owing to the coarseness of the medullar meshwork

* *Loc. cit.* Taf. i. fig. 4.† *Loc. cit.*‡ *Loc. cit.* pl. iii. fig. 10.

and the fact that the spaces in the meshwork are often approximately circular in transverse section, it is not always easy to detect the *water-vascular tubes*. They are, however, often quite easy to see, and in such cases I have seen two on each side—a

Text-fig. 4.



Transverse section through the strobila of *Ichthyotenia (Acanthotenia) varia*.

d.v. Dorsal water-vascular tube. *l.m.* Layer of delicate longitudinal muscles lying between cuticular and cellular subcortical layer. *T.* Testis. *U.* Cavity of uterus. *vt.g.* Vitelline gland. *v.v.* Ventral water-vascular tube.

dorsal and a ventral, fairly evenly superposed. The calibre of these vessels is not large, and they do not differ greatly in size. I have observed branches going towards the exterior, but have not traced them as far as an opening. The longitudinal trunks lie sometimes to the inside of, and sometimes above and below, the vitelline mass.

The *testes*, as can be best seen in transverse sections, form a layer, only one deep, of 80-100, or even more, in a single proglottid. While there is not a median space entirely free from testes in this species such as occurs in some other species of the genus, the testes are often not quite so densely arranged in the median area; they occur there, however, even when the uterus is fully formed, in the thickness of the strands which form its diverticula. The testes do not extend back to the sides of the ovary, but anteriorly they may (or may not) reach quite to the end of the segment.

The *vas deferens*, after issuing from the cirrus-sac, forms a dense coil, which extends over about half of the breadth of the proglottis. It lies at right angles to the long axis of the proglottis, and is directed neither forwards nor backwards. The tube forming this coil is thin-walled and of wide calibre. Within the cirrus-sac the sperm-duct is also coiled, but it is here of much less calibre. I was not able to see any hooks in connection with the copulatory apparatus. The aperture of the cirrus-sac was always in front of the orifice of the vagina. The *cirrus-sac* is flask-shaped as in other *Ichthyoteniids* and in many tapeworms, but there is not so sharp a demarcation between the two regions as is so commonly the case. The walls are thin and obviously muscular; they are not thicker in the neck of the cirrus. It is necessary to insist upon the muscularity of the walls of the cirrus-sac since Schwarz* has written of that of *Ichthyotenia nattereri*: "Die Blase (*i. e.* of the cirrus-sac) ist dünn, nicht muskulös." It should be mentioned that the alternating generative pores lie some way behind the middle of each proglottid †.

The *ovary* is, as usual, in two portions, with a slender bridge in the middle line uniting the two. The contour of the ovary, though irregular, is not pulled out into digitiform processes as in *Ichthyotenia biroi*. The *vagina* runs parallel with the cirrus-sac and posterior to it, as already mentioned. This region of the tube is wider than that lying behind; but the vagina is here not coiled, and, indeed, scarcely wavy in outline. Posteriorly between the wings of the ovary the vagina is coiled for a short distance.

* *Loc. cit.* p. 20.

† In one proglottid, which was fully ripe and contained numerous embryos, I observed a remarkable variation which I have not seen before in a tapeworm. The cirrus-sac with the succeeding large and complex coil of the *vas deferens* was particularly obvious; but the most careful examination failed to show a vagina lying either in front of or behind the cirrus-sac. But by following up the vagina from the ovary forwards it was found to bend in the reverse direction and to open on to the opposite side of the proglottid, nearly on a level with, but slightly behind, the line of opening of the male pore. I regard this state of affairs as merely a variation, but I have not read of any parallel instance.

The dilated region of the vagina (the dilatation is very slight) has apparently not got a ciliated lining. It has a covering of glandular cells externally which is obviously continuous with, and presumably derived from, the glandular subcuticular layer of the body generally. The shell-gland is large and conspicuous, and the "Schluckapparat" is particularly muscular and strong. I have observed a duct arising from each peripheral vitelline series, and there is in short nothing of particular note in this part of the generative system.

Text-fig. 5.

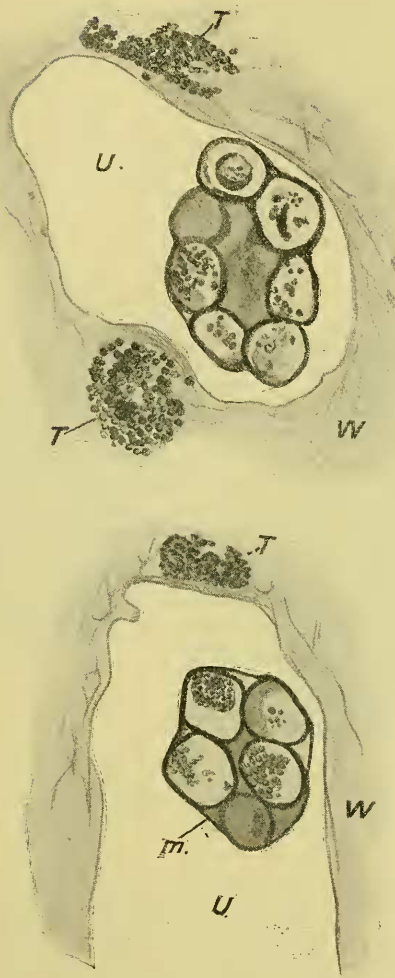


View of a ripe proglottid of *Ichthyotænia (Acanthotænia) varia*, to illustrate the extent of the mature uterus.

E. Egg-clumps scattered through the uterus, which occupies the greater part of the proglottid. *T.* Testes.

The *uterus* of this species when fully formed and containing embryos occupies a good deal of the middle region of ripe proglottids (see text-fig. 5). Its aspect in transverse sections is quite like that of *Ichthyotænia nilotica* described above, and no definite specific differences appear to me to be obtainable from a comparison of these organs. The eggs, however, are highly characteristic when the present species is compared with *Ichthyotænia nilotica*. They are disposed for the most part within the cavity of the uterus in clumps of varying numbers, perhaps 12-20 in each batch of eggs. Three or four of these, or often more, may be visible in a single transverse section. The mode of aggregation of the individual eggs (which, of course, contain embryos) in *Ichthyotænia varia* is thus different from that which is found in *Ichthyotænia nilotica*. They also appear very considerably larger, the difference in size being principally a question

Text-fig. 6.



Transverse sections through two compartments of the uterus of
Ichthyotænia (Acanthotænia) varia.

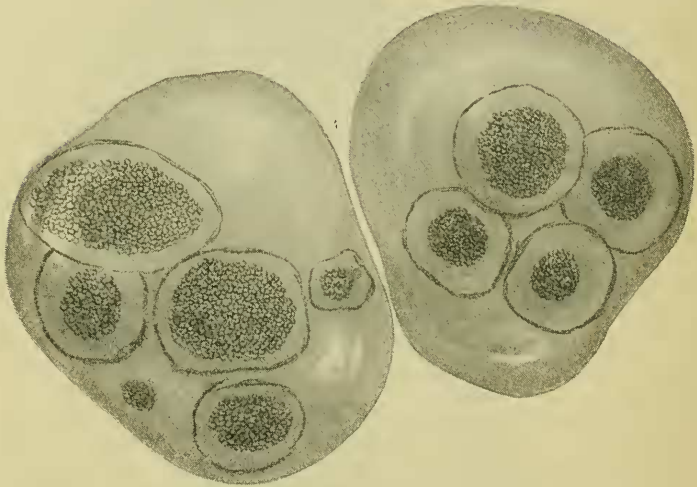
m. Outer sheath enclosing several embryos, each of which has also its own separate sheath. *T.* Testes. *U.* Cavity of uterus. *W.* Wall of uterus.

In the upper figure a clump of embryos is shown in which the outer membrane is not present or just represented by a rudiment on the left side. In the lower figure is shown a clump of embryos in which there is an outer sheath involving the whole mass.

of the increased shell. Text-figure 6 (p. 21) shows a clump of eggs in transverse section within a compartment of the uterus, pressed to whose boundary walls on either side is a testis. This figure may be compared with text-figure 3 (p. 13), which illustrates a corresponding view of an egg-clump in *Ichthyotenia nilotica*.

The masses of eggs of *Ichthyotenia varia* are, however, sometimes rather different from that represented in the drawing to which attention has just been called. Occasionally (as shown in text-figs. 6, 7) each mass of eggs is surrounded by a common

Text-fig. 7.



Two isolated masses of embryos from the uterus of *Ichthyotenia (Acanthotenia) varia*, viewed entire as transparent objects, to show the sheath which encloses a variable number of embryos.

sheath or shell, within which lie the eggs, or rather embryos, each with its own shell. The same state of affairs is quite plainly visible in preparations of a proglottid mounted entire (text-fig. 5) in glycerine, where the eggs appear to be contained within a glass ball. In the text-figure to which I have referred the outer sheath is represented as thin; it is often considerably thicker, and I have seen it with a few thin obliquely-set spiny processes. An aggregation of the eggs within the uterus appears also to occur in *Ichthyotenia saccifera* of v. Ratz, but there are not sufficient details given to compare with the conditions observed by me in *I. varia*. As to the egg-masses enclosed within a common sheath, they suggest spores within a sporangium, and give rise to the idea (which I admit to be otherwise unsupported) of the division

of an originally single ovum to form a number—thus lying within one sheath.

In describing the last mentioned species I have referred to a scolex which probably belongs to a third species, and a further examination of this and of some other fragments has convinced me that this is so, and that I am right in describing these worms under a different name.

The present species is intermediate in size between the two last mentioned. As already suggested, it is probably at least 40 mm. in length, for the largest fragment, that including the scolex, is quite 34 mm. long. The head is wider than the body which follows, and the greatest breadth is not attained for some time; the elongated ripe segments are about .5 mm. in width. This worm is therefore much more slender than *Ichthyotenia varia*. The rostellar region was depressed and the four suckers look distinctly upwards. I ascertained that the scolex was densely beset with fine spinelets as in other species. There are, of course, no hooks. The neck is very short indeed, and the proglottids very soon get to be as long as they are broad; later on they become about three times as long as they are broad.

The general structure of the body when examined in transverse and longitudinal sections is very like that of *Ichthyotenia varia*, which has just been described. The strands forming the meshwork of the parenchyma are, however, much finer, and the interstitial homogeneous ground substance is deeply stained, whereas a corresponding immersion in the staining-fluid of pieces of *Ichthyotenia varia* produced no result in the way of tinging the ground substance.

The segments, however, from which I made these sections, although elongated, are rather younger than those which I examined (and which alone I was able to examine) in *Ichthyotenia varia*. The outer longitudinal muscular layer lying outside of the subcuticular layer was obvious; but, as in *I. varia*, I could find no other definite longitudinal layer. The subcuticular cells were strongly developed and very darkly stained. The *water-vascular tubes* are two on each side and superposed, the dorsal lying often fairly accurately above the ventral.

The disproportion in calibre between the two tubes and their actual size is greater than in the last species. I can find no trace of transverse vessels. I could find no calcareous bodies, which are present, though not abundant, in *I. varia*. The principal difference, however, between the present species, which I propose to call *Ichthyotenia gracilis*, and *I. varia* lies in the reproductive organs. In the first place, the opening of the external pore is rather nearer to the middle of the proglottids—sometimes, in the case of shorter proglottids, actually median on the lateral margin. It is never so posteriorly situated as in *I. varia*. I counted 80 *testes* in one proglottid, which are more definitely arranged in this species in two lateral bands, the median area being largely and

sometimes entirely free from testes. The *sperm-duct* shows an important difference from that of *Ichthyotenia varia*. Almost immediately after leaving the cirrus-sac it becomes dilated into a vesicula seminalis in a fashion not met with in the last described species. Moreover, the coil of sperm-duct which ensues is considerably less in extent than that of *I. varia*, and instead of running out towards the middle of the segment is directed rather obliquely and forwards. There is thus a greater angle formed with the vagina. The structure of the cirrus-sac appears to me to show no obvious differences from that of the *Ichthyotenia* which has just been described. The vas deferens is coiled within it in a precisely similar fashion. As a rule the vagina, which lies parallel with the cirrus and is here somewhat dilated, lies posteriorly to that sac; but I found it in one instance to open in front of the cirrus-sac. *Ichthyotenia gracilis* thus differs in this character also from *Ichthyotenia varia*. In the neighbourhood of the ovary the vagina is a good deal coiled; but my account of the female organs of this species is very incomplete, since they were not fully mature. The shell-gland was large and well forward in development; but I could not definitely recognise the lateral vitelline strips. The uterus was in the condition of a delicate thread commencing anteriorly and extending far back in the middle line of the segment.

I am therefore able to distinguish plainly three species of *Ichthyotenia* occurring in the gut of *Varanus varius*, which are apparently graduated in size, and of which the smallest (to which I do not venture to give a name for the present) is the only one that bears any external likeness to the only species of *Ichthyotenia* (viz. *I. tidswelli*) as yet recorded from this particular species of *Varanus*. I have, however, shown ample reasons for regarding it as different. There can also be no question as to the marked distinctness of *I. varia* and *I. tidswelli* quite apart from size, and here there appears to be too great a discrepancy to allow of specific identity. *I. tidswelli* differs from my species by its total lack of calcareous corpuscles, by the alternating relative position of cirrus-sac and vagina, by the disappearance of the uterus and the lodgment of the ripe ova in the parenchyma*, by the freedom from testes of the middle region of the proglottid, and by the strong muscular layers of longitudinal fibres lying within the subcuticular layers of cells.

With my *Ichthyotenia gracilis* Johnston's *I. tidswelli* agrees more closely; yet they are, as I think, different. In the first place, *I. gracilis* cannot possibly be described as "like a piece of fine white thread," a description applied by Johnston to *I. tidswelli*. I can find neither in *I. gracilis* nor in *I. varia* the strong muscular layer figured by Johnston, and also in other species by Schwarz. Finally, the existence of what may be

* The author of the paper upon *I. tidswelli* is not, however, able to insist absolutely upon this.

termed a vesicula seminalis appears to be distinctive of *I. gracilis*, and thus contributes largely to the establishment of its distinctness as a species.

This latter character also precludes the possible identification of *I. gracilis* with either of the two species described by v. Ratz, from which both *I. gracilis* and *I. varia* differ also in other particulars. In *I. biroi* the genital pore lies in front of the middle of the segment instead of behind it, the neck is long, and the proglottids, even posteriorly, are not plainly separable to the eye; the water-vascular tube is single on each side. It is therefore not identical with either of my species. In *I. saccifera* the positions of male and female pores alternate as in *I. gracilis*; but the cirrus-sac is described as round, as opposed, I presume, to oval, which is its shape in *I. gracilis*, in which species, moreover, the proglottids are longer; but the two species are obviously very near to each other.

Finally, I do not think that these species can be confused with v. Linstow's *Acanthotenia shipleyi* from *Varanus salvator*, for it is very minute, only 13·8 mm. in length by 1·4 mm. in breadth; the segmentation is not marked; the cirrus-sac lies behind the vagina and is crescentic in shape. The author, however, seems to have missed the marginally situated vitelline glands, since he identifies as such what is, I think, certainly the ovary. The description setting forth the characters of a new genus and a new species is, however, a very brief one.

§ *An Ichthyotæniid from the Indian Cobra (Naja tripudians).*

OPHIDOTÆNIA NALÆ, gen. et sp. n. (See p. 35.)

The genus is already known to exist in a good number of snakes, of which a list was given by v. Linstow in 1907* and by Schwanz in the following year †. There are at most seven species known from snakes, if we except *Crepidobothrium gerrardi* ‡ from *Boa*, and regard it, mainly by reason of its horseshoe-shaped suckers, as a distinct genus. I have now to describe a form which occurs in a species of snake which has not hitherto yielded examples of the genus. I obtained at least three specimens (there were three scolices) of an Ichthyotæniid from an Indian Cobra which died in the Society's Gardens on April 18th, 1912. The longest individual measured, after preservation in alcohol, 110 mm., and had a greatest breadth posteriorly of 1·5 mm.

The anterior end of the body gradually narrows up to the small scolex, which is, however, wider than the neck which immediately ensues. In none of the specimens was the rostellum very conspicuous for its size and extension beyond the suckers. Indeed, I found that in the specimen which I examined by means of transverse sections there was no prolongation of the head at all

* "Helminthen von Java," Notes Leyd. Mus. xxxix. 1907-8, p. 85.

† "Die Ichthyotæniën der Reptilien, &c.," Inaug.-Diss. Univ. Basel, 1908.

‡ Baird, Proc. Zool. Soc. 1860, p. 446; Monticelli, Atti Soc. Nat. e Mat. Modena, (4) i. 1899, p. 9.

beyond the suckers. The very first section of the series, which was nearly transverse, showed simply two suckers back to back with very little tissue between them. The scolex, indeed, appears to be very like that of *Ichthyotenia nattereri* as figured by Schwarz. Naturally, therefore, as in that species, the present is provided with neither rostellum nor a fifth sucker. Nor is there the least trace, that I can discover, of the presence of minute spines upon the scolex, such as characterise the species of *Ichthyotenia* from *Varanus*. I gather from Schwarz that in other *Ichthyotæniids* from *Ophidia* there is the same lack of minute spinelets upon the rostellum. I may add that I cannot find these spines lining the cavity of the suckers, a matter upon which I lay some weight, since Johnston has particularly asserted their presence in this situation in *I. tidswelli*.

The actual neck of this worm—*i. e.*, that portion of the strobila immediately following the scolex—is short, the segmentation of the body commencing early. The proportion between depth of the segments and transverse diameter is more equal here than later, where the body appears, on account of its great breadth, to be very thin. Also the dorso-ventral diameter is not greater in the neck-region than posteriorly. In transverse sections through this neck-region, one important difference is apparent between this species and those which I have been able to examine among the species peculiar to the genus *Varanus*. The parenchyma of the body is uniform throughout, and appears to contain no muscular fibres at all. It may be that there are a few which I have missed on account of their tenuity; but it is quite clear that there is in the present species nothing like the thick encircling layer of longitudinal fibres which I have described above in *Ichthyotenia nilotica* and *Ichthyotenia* sp. from the Nilotic Monitor. This peripheral layer of muscles, were it present, could hardly, I should imagine, have been missed, so conspicuous is it in the two species from *Varanus*.

In the wider posterior part of the body the segmentation is quite clear, though the segments, as is the case with the other species of the genus, do not overlap. They get to be about twice the length of their width. In transverse sections, through not fully mature segments, the width in comparison to the depth is greater than that which is figured by Schwarz for some species of *Ichthyotenia* from Serpents. In some quite mature segments which I examined the difference from *I. nattereri*, etc., in this respect appears to be less; and in those segments the two ends of the section were wider than the middle region and formed an almost circular-projecting area, the whole section having thus a dumbbell-form with a long cross-bar. The minute structure of the body differs in some respects from that of the *Ichthyotænia* considered in the present communication, but seems to agree on the whole with that of species of *Ichthyotenia* from *Ophidia*. The cuticle is thick and homogeneous; the layer of longitudinal fibres beneath it is very distinct. The sub-

cuticular layer of large pear-shaped cells is deeper than in the *Ichthyotenia* from *Varanus*, and, like the layer in them, is very conspicuous and deeply staining. Some way below this glandular layer is a layer of stout longitudinal fibres, such as are figured by Schwarz in species of *Ichthyotenia* from Serpents, a layer which I have been quite unable to find in such species from *Varanus* as I have examined. This layer in the present species is very conspicuous, and the differential staining of logwood emphasises it very well. The layer is usually more than a single fibre deep, but in places only a single fibre deep. The greatest number of fibres which I have found in a dorso-ventral direction is not more than four. The layer thus appears to be thicker than in *Ichthyotenia nattereri* and *I. calmettei* figured* by Schwarz. The layer seems, as Schwarz has pointed out, to form the boundary line between the cortical and medullary regions of the proglottids. The latter author has directed attention to a peculiarity in the disposition of the transverse fibres which differs from that of all other tapeworms. He described and figured† these fibres as lying within—i. e., not on—the boundary of the medullary parenchyma. I have myself observed in the present species many such fibres in proglottids not fully mature. In fully mature proglottids I have not detected them. They are irregular and certainly occupy a good deal of the medullary region. They are not, however, by any means so plain as the longitudinal fibres just described.

The *water-vascular tubes* in the neck-region are plainly two on each side. They show a character here which is at least not very common among Tapeworms. Both the tubes, which are fairly accurately superposed, have distinctly thick walls and are rather larger than usual. Moreover, the lumen is slit-like, the tubes presenting the appearance of being compressed dorso-ventrally; there is no doubt that in the fully mature proglottids only one of these tubes is present on each side of the body.

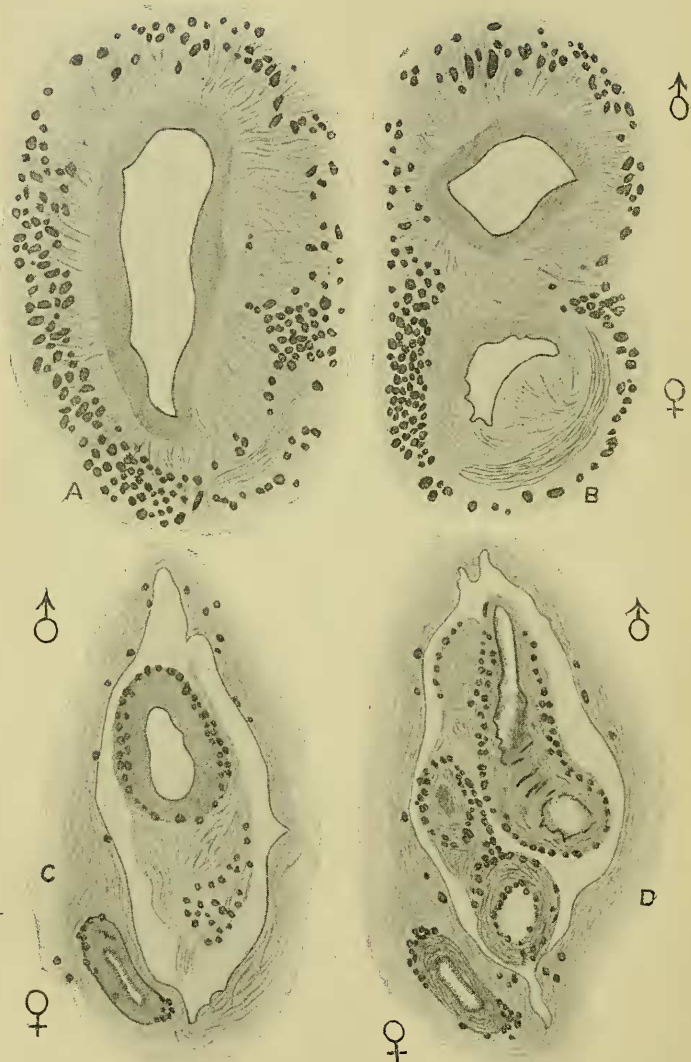
The *generative organs* conform with the Ichthyotæniid plan, but show numerous differences in details from those of the other species already considered in the present paper. The *testes* present the usual arrangement, but are, perhaps, more strictly confined to the lateral regions of the proglottid than in some other species described in the present paper. When they are fully ripe the testis seems to become entirely converted into a mass of spermatozoa, which does not wholly fill the cavity in which it lies. In transverse sections a series of these cavities are seen to lie side by side, only separated by a thin strand of medullary parenchyma.

The *vas deferens* forms the usual Ichthyotæniid coil, but seems to be of less calibre than in the species of this genus from *Varanus*. This coiled region extends to quite the middle of the

* *Loc. cit.* Taf. i. fig. 4 and Taf. iii. fig. 10, *lm.*

† *Loc. cit.* Taf. iii. fig. 10, *tm.*

Text-fig. 8.



A series of transverse sections through generative ducts of *Ophidotania naia*.

- A. The cloaca genitalis. B. The extremity of the cirrus (♂) and the vagina (♀).
 C. The terminal part of the cirrus lying without the cirrus-sac (♂) and the
 vagina (♀) already narrowed in calibre. D. Cirrus-sac (♂) containing coiled
 cirrus; (♀) vagina. The glandular cells besetting the cirrus are shown black.

proglottid. The *cirrus-sac* is longer than broad, but not of a very regular oval; its walls are thin but muscular in structure, the number of fibres in a longitudinal section not appearing to be more than one or two. Within the *cirrus-sac* lies the *cirrus*, which widens out considerably in its last section—*i. e.*, that lying immediately after the external aperture; the *cirrus* lies in many coils and is throughout of considerable calibre. In structure it differs from the *cirrus* of many other tapeworms (see text-fig. 8) by the very thick layer of circular muscular fibres which surrounds it. The muscles are increased at the broad terminal portion of the *cirrus*. Outside the muscles is a layer of pear-shaped glandular cells which deck the whole of the *cirrus*. The same arrangement, or something very like it, apparently exists in *Ichthyotenia nattereri* according to the figure and description by Schwarz*. In that species, however, the glandular layer is neither so thick nor so widely distributed as in the present.

I have observed in several proglottids the complete protrusion of the *cirrus*, which is everted in the usual way and thus is broader at the base than at the tip.

I have found no protrusion of the *cirrus-sac* itself such as has been referred to by Schwarz. The *cirrus* when fully everted is not half the width of the proglottid. There is thus a difference from *I. nattereri*, in which species (very like the present in many respects) Schwarz asserts that the protruded organ equals in length the whole diameter of the segment. Moreover, he figures the *cirrus* as very much more closely coiled within the *cirrus-sac* and therefore longer than I have found to be the case with my new species. I have not found any spines upon the *cirrus*. As in many species of *Ichthyotenia*, the *cirrus* opens sometimes in front of and sometimes behind the vagina. The cloaca genitalis into which both open is of some depth.

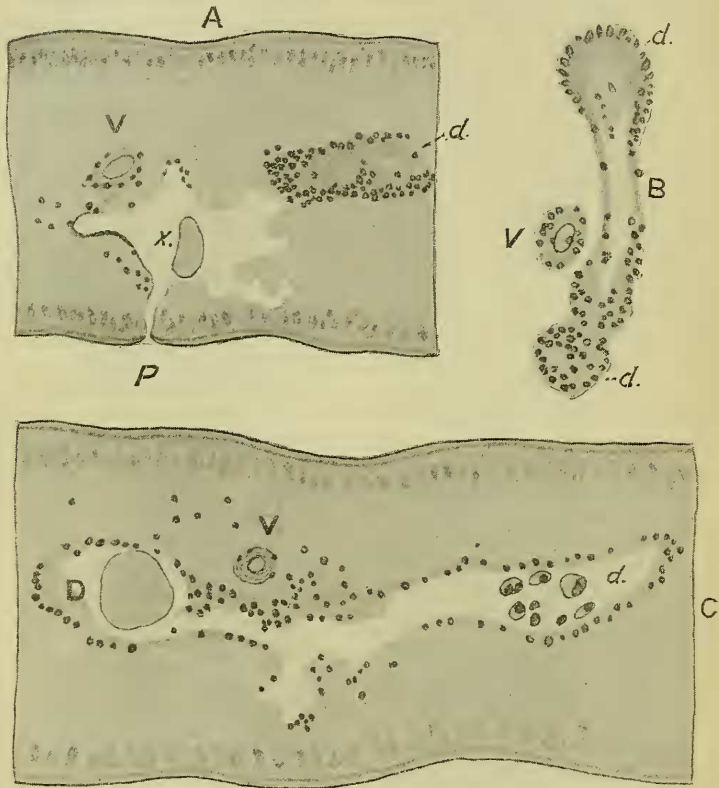
At its outer end (see text-fig. 8 B) the vagina is quite as wide as the somewhat dilated end of the *cirrus*; but it very soon narrows into a tube of less calibre. The wide distal region is fully as muscular as the *cirrus* and it is furnished in addition with a strong circular muscular sphincter. Outside of this is a layer of glandular cells, which forms with those belonging to the *cirrus*, and which have been already described, a common layer surrounding the two tubes in one circle. In this region the vagina is not ciliated. A little further back the vagina has its own separate coat of glandular cells as has the *cirrus*. Later on the vagina becomes narrower and is ciliated internally. It bends back in the usual position and is coiled posteriorly in the region of the ovary. The straight part of the vagina which passes backwards lies dorsally to the uterus, but not quite in the median line.

The *ovary* extends on either side up to the laterally placed vitelline strips. I could not find any signs of a *shell-gland* which

* *Loc. cit.* Taf. ii. fig. 5.

is so conspicuous in certain species from *Varanus* described above. On the other hand, the "Schluckapparat" was large and

Text-fig. 9.



Ophidotænia naie.

A. Section through a portion of a ripe proglottid.

d. A diverticulum of the uterus. *P.* External pore of the uterus. *V.* Vagina.
a. A mass of secreted substance lying within the main stem of the uterus.

B. A section through the uterus cut transversely and showing the diverticula (*d*) of the median stem. *V.* Vagina.

C. Part of a transverse section of a ripe proglottid.

In the centre is seen the uterus, the median stem of which sends down an outgrowth towards the exterior of the body, of which the external orifice is seen in **A.**

D. A mass of secreted substance lying in one diverticulum. *d.* Eggs in process of development lying in the other diverticulum. *V.* Vagina.

muscular. This and adjacent parts of the female ducts extended back beyond the ovary to the hinder border of the proglottid.

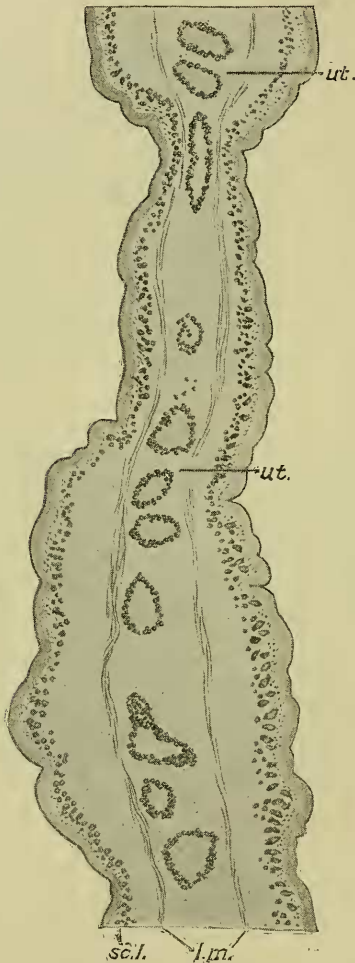
The *uterus* of this worm shows a very remarkable feature which in detail is different from anything that has been hitherto described in any tapeworm. I believe that I am right in saying that an independent uterine opening is not found in any of the Tetraphyllidea or Cyclophyllidea—that it is, in fact, confined to the Pseudophyllidea. The present species, allied to a genus which perhaps stands intermediate between the Tetraphyllidea and Cyclophyllidea, is thus so far unique in possessing independent uterine openings which lie, as in *Bothriocephalus*, etc., upon the ventral surface of the body. While there is this general resemblance to the lower group of tapeworms, there are plenty of differences in detail between the conditions which obtain in this species and those which characterise the Bothriocephalidae and their immediate allies. When the ripe proglottid is viewed as a transparent object in its entirety, *i. e.*, without undue pressure, the uterus is seen to occupy the middle region of the body, and to be a quite narrow tube with regular paired diverticula, which extend but a little way laterally.

In addition to this there were in the median line of the proglottid a series of medianly situate orifices, one behind the other, extending through the greater part of the proglottid and rendered especially conspicuous by virtue of the fact that granules of black pigment had accumulated in every instance near to these orifices. I could not in such preparations actually see the tube which put this series of orifices into communication with the underlying uterus. But the orifices, on focussing down, were quite plain and could not be missed. In transverse sections (text-fig. 9) all of the structural characters were easily confirmed and extended. The uterus is seen to occupy but a comparatively small space in the middle of the proglottid, by reason of which the present species contrasts with *Ichthyotenia varia* or *I. nilotica*. The uterus in a given section consists of a median stem which is a small tube; from this arise continually a series of paired diverticula, which are at times somewhat ear-shaped or crescentic in outline. The curvature is downwards and they expand at their blind ends (text-fig. 9 B). The diverticula furthermore show a difference in structure from the median stem of which they are outgrowths. Their exterior is more or less covered with a layer (text-fig. 9 A) of pear-shaped glandular-looking cells, which resemble those found decking the cirrus and which are also of the same nature as the glandular cells of the subcuticular layer.

These uterine pores are quite as visible in sagittal sections (text-fig. 10) and are then seen to exist along the entire length of the proglottid, being situated at intervals from each other. Such sections also show very much better than the transverse sections the fact that the median stem of the uterus is continuous throughout the proglottid; they furthermore enable me to state that the number of paired diverticula of the median stem in a

given proglottid was over twenty; they doubtless vary, but it is important to note that they are numerous. In this particular

Text-fig. 10.



Sagittal section through part of a proglottid of *Ophidotænia naia*.

l.m. Longitudinal muscular layer. *sc.l.* Subcuticular layer.
ut. Diverticula of uterus seen in transverse section.

feature the present species does not differ in any way from other Ichthyotæniids. I do not think that the number of external

pores is as great as that of the diverticula. But I cannot reckon these pores up exactly. The actual pore itself is as a rule small, but its position is rendered obvious by the gradual thinning to a point of the cuticular layer on either side. Where the pore is small the downwardly directed tube from the median stem of the uterus is also slender and narrow.

Not infrequently, however, the pores are greatly enlarged, and in such cases I have observed the orifice plugged with granular matter exuding from the orifice. Very often too, and in association with the stretching of the uterine pores, the ventrally directed outgrowths of the uterus are much dilated. It might be suspected perhaps that these large "pores" are simply the expression of a rupture caused by the turgescence of the uterus. That this is not the case is shown by the thinning of the chitinous cuticle round the pore; it is clearly not torn across, as it would be were it a question of a rupture.

If there were any doubt as to this tube with its paired diverticula being the uterus, the existence of eggs within the tube dissipates that doubt. These possess a tolerably thick shell and they appear to resemble the eggs of *Ichthyotania varia*. But in addition to these eggs (which had segmented and were of course really embryos) there were others with no apparent shell (text-fig. 9, C d). Attention has been called to the diverticula of the uterus, which are small and whose walls are beset with numerous long-stalked pear-shaped glandular cells. If it were not for the comparatively wide lumen of these diverticula they might easily be mistaken for shell-glands—so similar is their glandular investment to that of a shell-gland. I am disposed, indeed, to believe that this is the actual function of the diverticula. For there are to be noted here and there in the uterus round homogeneous masses of a substance (text-fig. 9 A x, C d) which stains precisely like the egg-shell, and which may very well be a secretion of the glandular cells referred to. It will be furthermore recollected that this worm apparently does not possess a proper shell-gland*.

The function of the uterus is thus enlarged, and it is in this species not merely an egg-holder.

* It seems to me to be possible that an analogous state of affairs exists in *Mesocoestoides*. I have lately spent some time in studying a species of that genus from a black Serval, which I do not feel able to place accurately but have regarded as *M. litterata*. In the uterus masses of amorphous matter lie here and there among the embryos. This substance is represented by Hamann (*Zeitschr. f. wiss. Zool.* 1885) as a nucleated tissue, with which I cannot agree. I think that we have to do here, as in the species described above, with a secretion of uterine glands. The hinder part of the uterus is regarded by Hamann as the equivalent for shell-gland which he has stated to be absent in *Mesocoestoides*. Zschokke, however (*Mém. Inst. Genève*, 1889), has asserted the presence of a real shell-gland in the normal position. If a shell-gland is present in the species which I studied it is certainly very inconspicuous. I may point out, moreover, that in the genus with which the present paper deals the shell-gland may be present or absent. In any case, the commencement of the uterus in the *Mesocoestoides* examined by myself had a glandular wall, which quite possibly corresponds with the glandular diverticula of the uterus in the species from the Indian Cobra.

It should be mentioned that the eggs were not in any way aggregated into balls such as I have described in the species *Ichthyotenia varia*.

I have finally to point out that although I have not come across any description of external uterine pores in any Cyclophyllidean, Spätlich* has described and figured in *Tetrabothisrium* a cord of cells passing from the uterus which may well be, as he suggests, the remains of an external duct and pore. This comparison gains some additional force by other points of likeness between *Ichthyotenia* and *Tetrabothisrium* insisted upon by Lönnberg †.

§ On the Genera of the Family Ichthyotæniidæ.

Having surveyed the anatomy of a number of worms undoubtedly referable to this family of Tapeworms, it remains to be seen how they should be placed in genera, whether in more than one genus.

Relying mainly upon variations in the scolex and its suckers, Braun ‡, in 1899, allowed three genera—viz., *Ichthyotænia*, *Corallobothisrium*, and *Crepidobothrium*. Braun does not accept Lönnberg's § view that *Tetrabothisrium* should be included in the same family; neither does Ransom in his review of the Cyclophyllidea ||, nor Fühmann ¶ in his well-known essay upon the Cestodes of Birds. It appears to me, however, that Lönnberg's *Tetrabothisrium trionychium* is not congeneric with other species referred to that genus. It has, in fact, the peripherally situated vitelline glands of *Ichthyotænia*, with which it also agrees in its alternating generative pores. In *Tetrabothisrium* ** the generative pores are unilateral and the vitelline gland †† lies in front of the ovary.

While, therefore, there are certain points of agreement between *Tetrabothisrium* and *Ichthyotænia*, I do not think that they can be placed together so closely as would be implied by union in so small a subdivision as a Cestode family. Linstow ‡‡ gave the name of *Acanthotænia* to a small Ichthyotæniid from *Varanus salvator*, which name was also accepted by Johnston §§ in his account of a worm of the same genus from *Varanus varius*. This generic name is perhaps hardly accepted by Schwarz ||| in his recent monograph upon reptile Ichthyotæniids. But the last-named author has

* Zool. Jahrb. xxviii., 1909.

† Centralbl. Bakt. u. Paras. xv, 1894, p. 801.

‡ In Bronn's 'Klassen und Ordnungen des Tierreichs,' Bd. iv, p. 1706.

§ *Loc. cit.*

|| "The Tænioid Cestodes of North American Birds," Bull. U.S. Nat. Mus. no. 69, 1909.

¶ "Die Cestoden der Vögel," Zool. Jahrb. Suppl.-Bd. x., 1908.

** Spätlich. "Studien über Tetrabothisreen," Zool. Jahrb. xxviii. 1909; and generic diagnosis of Ransom.

†† Spätlich, *loc. cit.* Taf. 28, fig. 25, *dst.*

‡‡ Centralbl. Bakt. u. Paras. xxxiii. 1903, p. 534.

§§ Proc. Roy. Soc. N. S. W. 1909.

||| "Die Ichthyotæniiden &c.," Inaug.-Diss., Basel, 1908.

pointed out that in his opinion the reptile Ichthyotæniids do agree together and differ from the fish Ichthyotæniids in a number of points which he enumerates.

Schwarz comes to the conclusion that the reptilian Ichthyotæniids form a group which is characterised by the peculiar spiny outgrowths of the egg-shell, by the fine spines upon the rostellum, by the complicated coil of vas deferens and the protrusible cirrus-sac, and finally by the arrangements of the transverse muscles.

It does not appear to me that all of these features are distinctive of the reptilian Ichthyotæniids; for the coiled vas deferens is found in other species of *Ichthyotenia* not from reptiles; the fine spines upon the rostellum and early segments of the body are at least not to be found in the species from the Cobra which I describe in the present paper. The peculiar and delicate spines which deck the egg-shell are figured and described by Schwarz only in *I. nattereri*. The cirrus-sac does not seem to be protrusible in the way which he figures it, in the species of *Ichthyotenia* which I have described in the present paper from various species of *Varanus*. These characters are, in fact, not sufficiently general or not sufficiently distinctive to form a group. It must be admitted, however, that Schwarz suggests no name for his group, and thus does not unduly emphasize it.

It appears to me, on the other hand, that we can separate off as a distinct group of generic rank the species of *Ichthyotenia* which inhabit, not reptiles generally, but the lizard genus *Varanus* only. And if so, we must obviously term this genus *Acanthotenia*, adopting v. Liustow's name. The genus will be chiefly distinguished by the fine spiny covering of the scolex and anterior segments, and, as I think, also by the character of the longitudinal muscular layer. I am disposed to think that, as I have described in several species in the present paper, the internal layer of longitudinal fibres is found only in the anterior region of the body. A third character is perhaps afforded by the comparatively large size of the rostellar region, which is apt to be insignificant in the snake Ichthyotæniids. Further than this I do not think we can go at present. I propose the name of *Ophidotenia* for a new genus to include at any rate the species which I describe in the present paper from the Indian Cobra. Its most salient anatomical character is of course afforded by the structure of the uterus and by the ventrally and medianly placed external orifices of the same.

This genus *Ophidotenia* also contrasts with *Acanthotenia* in the lack of internal longitudinal muscles anteriorly and in their presence posteriorly. The inconspicuous rostellar region affords another distinguishing mark. In all of these characters, with the possible exception of those offered by the uterus, this genus agrees with other snake Ichthyotæniids. We cannot, therefore, as yet attempt to fix the limits of this genus *Ophidotenia*, in fact not until the structure of the uterus has been reinvestigated in other Ichthyotæniids in the light of my own discovery recorded here.

While it is not apparently possible to distinguish as a separate genus the two species which inhabit Amphibians, I am of opinion that Lönnberg's species from *Trionyx ferox* will prove to be not a *Tetrabothrium* or an *Ichthyotenia*, but another genus closely allied to the latter. At present the chief anatomical difference appears to be the limitation of the testes to the middle of the proglottid. Finally, I think that we must retain *Crepidobothrium* for those Ichthyoteniids, inhabitants of Ophidia, which possess horseshoe-shaped suckers.

§ *Résumé of the principal new Facts.*

It may be useful to abstract from the foregoing pages a short *résumé* of the more striking new facts which I have been able to ascertain:—

(1) Worms of a group belonging (in agreement with its usual definition) to the genus *Ichthyotenia* are more conveniently to be removed and placed in the genus *Acanthotenia* of von Linstow. These worms are found in several species of *Varanus* and are limited to that genus. The same species does not occur in more than one species of *Varanus*, but a single species of *Varanus* may contain more than one species of *Acanthotenia* parasitic in it.

(2) In some at any rate of the species of *Acanthotenia* there is a layer of longitudinal muscles limited to the head and neck and separating the medulla from the cortical region; these fibres are arranged in bundles. This layer disappears and does not occur in the body behind the neck.

(3) It follows from the above statement that in the body generally there is no demarcation between the medulla and cortex.

(4) The existence of numerous ventrally situated openings of the uterus in a tapeworm which is assigned to a new genus *Ophidotenia* is a new fact so far as concerns the Cyclophyllidea (=Tetracotylea).

(5) The diverticula of the uterus in *Ophidotenia*, instead of being of a character similar to the median stem, are closely beset with gland-cells and probably secrete the shell of the ova, there being no shell-gland in this worm. There is here a possible likeness to *Mesocestoides*, but the details are different.

(6) The mature eggs of *Acanthotenia varia* not only tend to cling together in balls, as has been described in other species of the genus, but a series of distinct eggs are enclosed also, in many cases, within a common sheath, which suggests a division of one original egg.

(7) A remarkable abnormality is recorded in the same species, where in one proglottid the male and female ducts open on to opposite sides of the body.